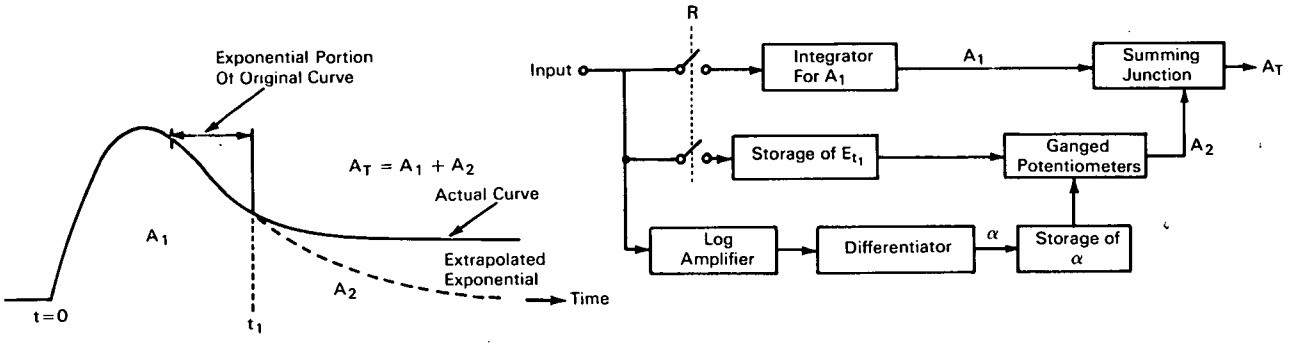
NASA TECH BRIEF

Computer Circuit Calculates Cardiac Output



The problem: To provide a simple automatic method of calculating cardiac output, which is defined as the blood volume per unit time and expressed in liters per minute. Typical time curves are derived and plotted from the output of a densitometer in the indicator dilution method, or a count-rate meter in the surface counting method. Previously, an extrapolated exponential curve derived from the time curve was plotted on semilog paper, and the area between the curve and baseline was calculated with a planimeter.

The solution: Electronic circuitry that automatically calculates this area under the curve and thereby eliminates the laborious manual manipulations.

How it's done: The circuitry calculates the total area A beneath the curve by summing the areas A_1 and A_2. Relay R closes at the onset of the curve and opens at t_1, which is an arbitrary point on the exponential portion of the original curve. Control of the opening of R can be by any convenient means provided that t_1 is always on the exponential portion of the original curve. When R opens, the voltage E_{t_1} (the voltage at point t_1) is automatically stored on a capacitor. Because an exponential curve becomes a straight line when plotted on log paper, the output of the log amplifier is a ramp function for the interval over which the input is an exponential time function. Also, because the derivative of a ramp function is a constant, the output voltage of the differentiator is proportional to α during the interval of the exponential. Since the maximum value of the downslope occurs during this interval, α may be stored by charging a capacitor through a diode to the maximum value of the output voltage from the differentiator.

By using cathode followers for isolation, output voltages proportional to $E_t\alpha$, and α may be obtained without discharging the capacitors. Then, using a ganged potentiometer, these voltages may be divided to produce an output voltage proportional to A_2. The summing junction adds this output to A_1 to produce a voltage proportional to the total area beneath the extrapolated curve.

Using similar techniques, the other parameters necessary for the determination of cardiac output are measured and fed into the computations and, with appropriate calibration procedures, computer output will indicate cardiac output directly in liters per minute.

(continued overleaf)

Notes:

1. This invention should prove to be a valuable tool for basic research in physiology.
2. This invention shows promise for use in doctors' offices as a diagnostic instrument.

Patent status: Title to this invention has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C. 2457 (f)), to Kaman Aircraft Corporation, P.O. Box 9431, Austin 56, Texas.

Source: Charles E. Mc Cullough of Kaman Aircraft Corporation under contract to Manned Spacecraft Center (MSC-274)